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Short communication

Effects of gamma radiation on the development of the Caribbean fruit fly (*Anastrepha suspensa*) and the subsequent development of its parasite *Diachasmimorpha longicaudata*

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Introduction

The rearing, transport and release of parasites for biological control of insect pests present special problems. It is sometimes desirable to maintain parasitoids in insect hosts that are themselves unable to develop and produce progeny. In this way a biocontrol agent can be conveniently shipped between laboratories or taken to or from the field, without also transferring the pest it attacks. For example, irradiated housefly (*Musca domestica* L.) pupae are used in explorations for foreign parasites. The flies are incapable of development, but are susceptible to parasitization. The irradiated pupae can be taken from the laboratory, exposed to parasites anywhere in the world for several weeks, and then returned with a minimum of difficulty through quarantine, along with any acquired parasites (Morgan *et al.*, 1986).

The following report describes the irradiation of late third instar (8–9 days old) Caribbean fruit fly larvae (*Anastrepha suspensa* (Loew) (Diptera: Tephritidae)) and the effects of different radiation dosages on both the development of the fly and the oviposition and development of its braconid parasite, *Diachasmimorpha longicaudata* (Ashmead), Hymenoptera: Braconidae.

Methods

Caribbean fruit flies were obtained from a colony kept for more than 10 years at the USDA-ARS Insect Attractants, Behavior, and Basic Biology Laboratory in Gainesville, Florida, USA. Mature larvae were collected as they left their corn-cob-grit based diet just prior to pupation and were immediately irradiated in groups of 200 with a ^{137}Cs source (Radiation Machinery Gammator M, Parsippany, N.J.) at a dosage rate of 1732 roentgens/min. Dosages used were 0, 1, 2, 3, 4, 5, 6, and 7 kR. Larvae from each exposure were then divided into two groups of 100 each and placed between two pieces of fine mesh fabric (organza) held in a 10 cm diam. embroidery ring. One ring from each dosage pair was placed for 2 h in a 30 × 30 × cm plexiglass cage containing ca. 100 parasites (*D. longicaudata*) of both sexes. The other ring was held in an empty cage. After exposure to parasites, larvae were placed in cups of damp vermiculite and allowed to pupate. Adult insects were counted as they eclosed. There were 10 replicates at each dosage. A regression analysis (SAS Institute, 1982) of changes in percent of larvae completing development at increasing radiation doses was performed.

To determine the fertility of females surviving exposure to 2 and 3 kR, large numbers (3–4,000) of late third instar larvae were irradiated while others from the same cohort were not exposed to radiation and held as controls. Twenty-five adult mated females (i.e. kept with males until 12 days of age) from each dosage group were placed in a 400 ml plastic cup covered with organza cloth. The bottoms of the cups were replaced with an oviposition surface consisting of beeswax impregnated cloth. The modified cups were then fitted into unmodified 400 ml cups which contained a few ml of water. This provided a humid environment near the bottom of the upper cup and prevented the eggs from dessication. After 3 h 100 eggs were removed from the cloth and placed on damp black filter paper in a covered 9 cm diam. petri dish. Hatched larvae were counted and removed daily for a period of five days.

Results and discussion

On the average, fifty percent of the control larvae (no irradiation or exposure to parasites) developed into adult flies. The number of eclosed adults fell rapidly with increasing radiation dose until at 3 kR, less than 1% completed development (Fig. 1, $r^2 = 0.57$, $P < 0.0001$). No adults were recovered from those larvae irradiated at 4 kR or greater. However, the development of the parasite *D. longicaudata*, was uninfluenced by the dosage received by its host (Fig. 1; $r^2 = 0.0003$, $P < 0.87$).

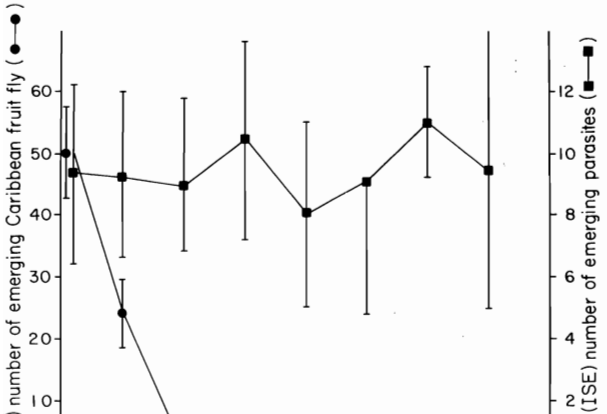

Fig. 1. The effect of radiation dose on the mean number (± standard error) of adult Caribbean fruit flies (circles) and braconid parasites (*D. longicaudata*) (squares) emerging from treated fly larvae.

Of the 100 eggs each obtained from unirradiated females, 86 hatched. In 2 replicates of 100 eggs each from females irradiated as larvae at 2 kR, 25 and 28 respectively hatched. No eggs were produced by the females exposed to 3 kR as larvae.

There is a substantial effect of radiation on the development of the Caribbean fruit fly, but the changes induced in the fly do not affect its use as a host for *D. longicaudata*. This may have implications for the mass rearing and inundative release of this parasite as a biocontrol agent of the fly. Pupae from irradiated larvae and containing parasites could be shipped, handled, and set out for parasite emergence without the fear of fertile flies emerging to contaminate the area.

Relatively low radiation doses applied in the larval stage are effective in stopping development and/or producing infertile adults. At 3 kR few adults emerge, and the females that do, lay no eggs. No Caribbean fruit fly adults emerged after a 4 kR dose. In contrast the lethal radiation dose applied to late instar larvae of the oriental fruit fly (*Dacus dorsalis* Hendel) is 6.3 kR (Burdett & Seo, 1971) and in Mediterranean fruit fly, *Ceratitis capitata* (Wied.) it is 5.6 kR (Hooper, 1971). Moreover, in sterilizing adults through pupal irradiation, Caribbean fruit flies are sterilized at lower doses than the Mediterranean fruit fly. No eggs were laid by Caribbean fruit flies after exposure to 1 kR in the pupal stage (Calkins *et al.*, 1988) while in the latter, females laid eggs for some days after exposure to 9 kR, and 1.5% of these hatched (Hooper, 1971). Subsequent comparisons may find that *A. suspensa* is indeed relatively vulnerable to gamma radiation.

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